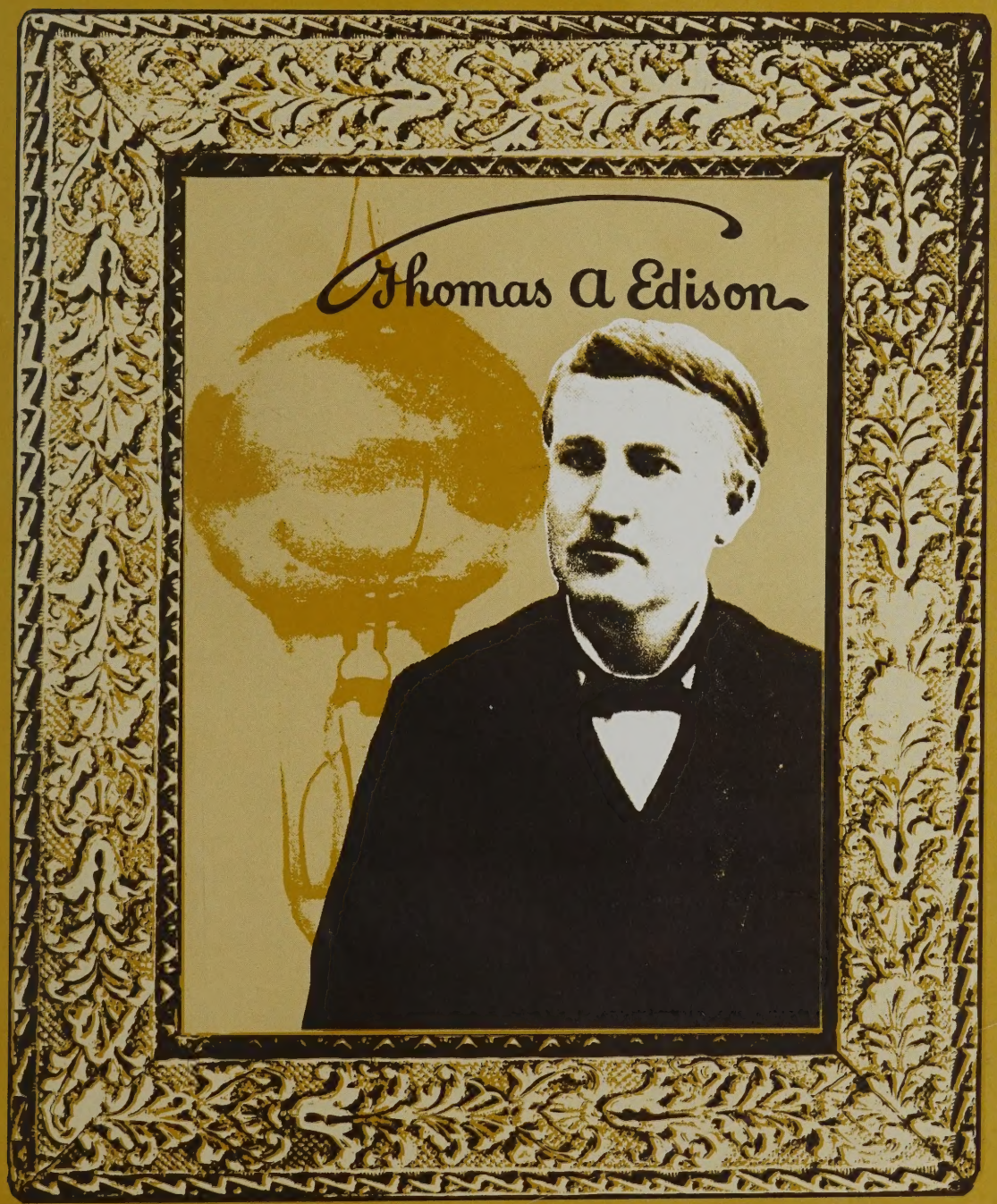
THE MONTHLY NEWS MAGAZINE OF THE NATIONAL BUREAU OF STANDARDS September 1975

DIMENSIONS/NBS



A PUBLICATION OF THE UNITED STATES DEPARTMENT OF COMMERCE

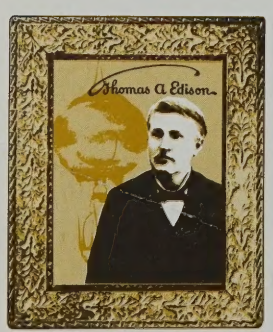
NATIONAL BUREAU OF STANDARDS

DIMENSIONS NBS

SEPTEMBER 1975 / Vol. 59, No. 9 / ISSUED MONTHLY

CONTENTS

Nat. Bur. Stand. (U.S.) DIMENSIONS/NBS
CODEN:DNBSBG 59(9) 193-216
Superintendent of Documents Catalog No. C13.13:59/9
Library of Congress Catalog No. 25-26527



Cover: Men like Thomas Edison have exhibited the inventiveness that Americans are noted for. Yankee ingenuity is being called on today to help in meeting the pressing National need of energy self-sufficiency. See story beginning on page 204.

U.S. DEPARTMENT OF COMMERCE
Rogers C. B. Morton, Secretary
Betsy Ancker-Johnson
Assistant Secretary
for Science and Technology
NATIONAL BUREAU OF STANDARDS
Ernest Ambler, Acting Director
Prepared by the NBS Office of
Information Activities
Washington, D.C. 20234
William E. Small, Chief
Richard S. Franzen,
Chief, Editorial Section
Sharon A. Washburn,
Managing Editor
Juli Kelley,
Associate Editor
Contributors
L. Kenneth Armstrong, Mona Bergenfeld, Dottie Hafer, Kent T. Higgins, Madeleine Jacobs, Stanley Lichtenstein, Frederick P. McGehan, R. David Orr, Alvin L. Rasmussen, Arthur Schach, Collier N. Smith, Carol M. Sussman
Visual Editor
Richard E. White

Formerly the TECHNICAL NEWS BULLETIN of the National Bureau of Standards.
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, $9.45, foreign, $11.85, single copy, 80 cents. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1976.

Data Protection Through Cryptography

*by Dennis K. Branstad**

COMPUTER networks may be the Federal paymasters of the future. Even today, computers typically process the payroll within each agency, print the checks at the Treasury Department, and credit the employees' accounts in local banks. However, several days often pass between these transactions.

If this information was electronically transmitted among computer facilities, it would arrive almost instaneously. A vast number of automated functions could in fact be handled faster and more efficiently by "linking" independent computer facilities on a broader scale. However, over this technologically feasible vision of a vast computer

turn page

network hangs the spectre of accidental or intentional misuse. Consider, for example, the real possibility of an unscrupulous individual using electronic techniques to divert funds for personal advantage. This, of course, is a human problem. However, technology can provide the solution.

The National Bureau of Standards' Institute of Computer Sciences and Technology (ICST) is working on technology to protect data in computer systems. One effort to provide data protection through encryption technology is being carried out in the Systems and Software Division where a Federal standard is being prepared.

* Dr. Branstad is a Computer Security Project Leader within the NBS Systems and Software Division.

Computer cryptography is achieved through the use of an algorithm—a set of rules for accomplishing a specific task. An algorithm specifies the mathematical steps needed to encrypt the data. A number, called the "key," controls the encryption process. When data is encrypted, it is changed into an unintelligible form. The encrypted data can be decrypted—returned to its original, intelligible form—only by authorized receivers who have the same encryption key. The data is protected by keeping the key secret.

The processes of encryption and decryption can be used to protect the confidentiality of data because the data cannot be read without proper authorization. They can also be used to protect the integrity of data because any modification of the data in encrypted form becomes apparent when it is decrypted.

An electronic device can be constructed to perform the required steps of the encryption/decryption processes both reliably and efficiently. Modern technology makes it possible to perform many complex functions in a device incorporating a single electronic "chip." This technology makes possible the inexpensive and handy arithmetic calculators of today. The nearly 14,000 electronic logic elements needed to implement the data encryption algorithm may be contained in such a chip which is less than .635 centimeters (1/4 inch) on each side. The costs of producing this piece of electronic hardware may be as low as $10 after the initial costs of production have been recovered.

An Algorithm

ICST sought an encryption algorithm for promulgation as a Federal Information Processing Standard (FIPS). This algorithm would have to provide a high degree of security, security based not on the secrecy of the algorithm itself but only on the secrecy of the key. The Institute solicited for suitable encryption algorithms and selected one submitted by the International Business Machines Corporation. This algorithm was published as a proposed standard on August 1, 1975, in the Federal Register.

Publication of the algorithm initiated the Federal standards-making process in this area. It is expected that adoption of the algorithm as a Federal standard will lead to voluntary adoption of the algorithm by computer users outside the Government. In fact, about 400 people from private organizations, both foreign and domestic, requested the algorithm after it was published for comment in the March 17, 1975, Federal Register. The size of the combined Federal and interested private sector market for a standard electronic encryption device should help bring the cost down.

First Users

When a Data Encryption Standard is established, it is expected to find many early uses such as protecting transactions conducted by the Federal Reserve System. These transactions often include the electronic transfer of vast amounts of money among the twelve Federal Reserve regions covering the United States.

In addition, the Federal Home Loan Bank Board has solicited for data encryption protection to be incorporated in its future procurements

of data processing equipment. The requirements that have been defined for this protection can be satisfied through the use of this data encryption algorithm.

Estimates of grain production and oil reserves have a significant effect on the commodity market or the stock market. Acquisition of this information as it is being electronically forwarded to Washington and before it is publicly released could give an individual an unfair advantage in reaping tremendous financial returns. Use of data encryption can prevent the possibility of such an event.

Other Uses

In addition to protecting transmitted computer data, devices implementing the Data Encryption Standard may be used to authenticate the holder of a banking or credit card. Information (the encryption key) known only by the authorized holder of a card may be used to decrypt information stored on the card and hence to gain access to modern, automated banking terminals or to prove the validity of a credit purchase of merchandise.

Access to a computer network having sensitive information may be granted or denied to an individual based on the individual having or knowing a proper encryption key. Control of access to computers and networks may be enforced by developing new technologies based on encryption techniques.

"Computer networks are emerging as a powerful national force touching every individual in Society" (*DIMENSIONS/NBS*, April 1975). NBS is providing a means for protecting data being transmitted within those networks. *continued on page 214*

The art of cryptography, or literally, "hidden writing," developed independently in a number of ancient civilizations, including Egypt, India, and Mesopotamia. By systematizing cryptographic techniques, the ancient Arabs became the first to transform this art into a science. The message concealed in the cryptogram expresses the relationship between cryptography and the computer.

RRFYM ATGTC RATFC FAEEO REERO

NPDPS NORDT SCTHA TMPEE NMNYY

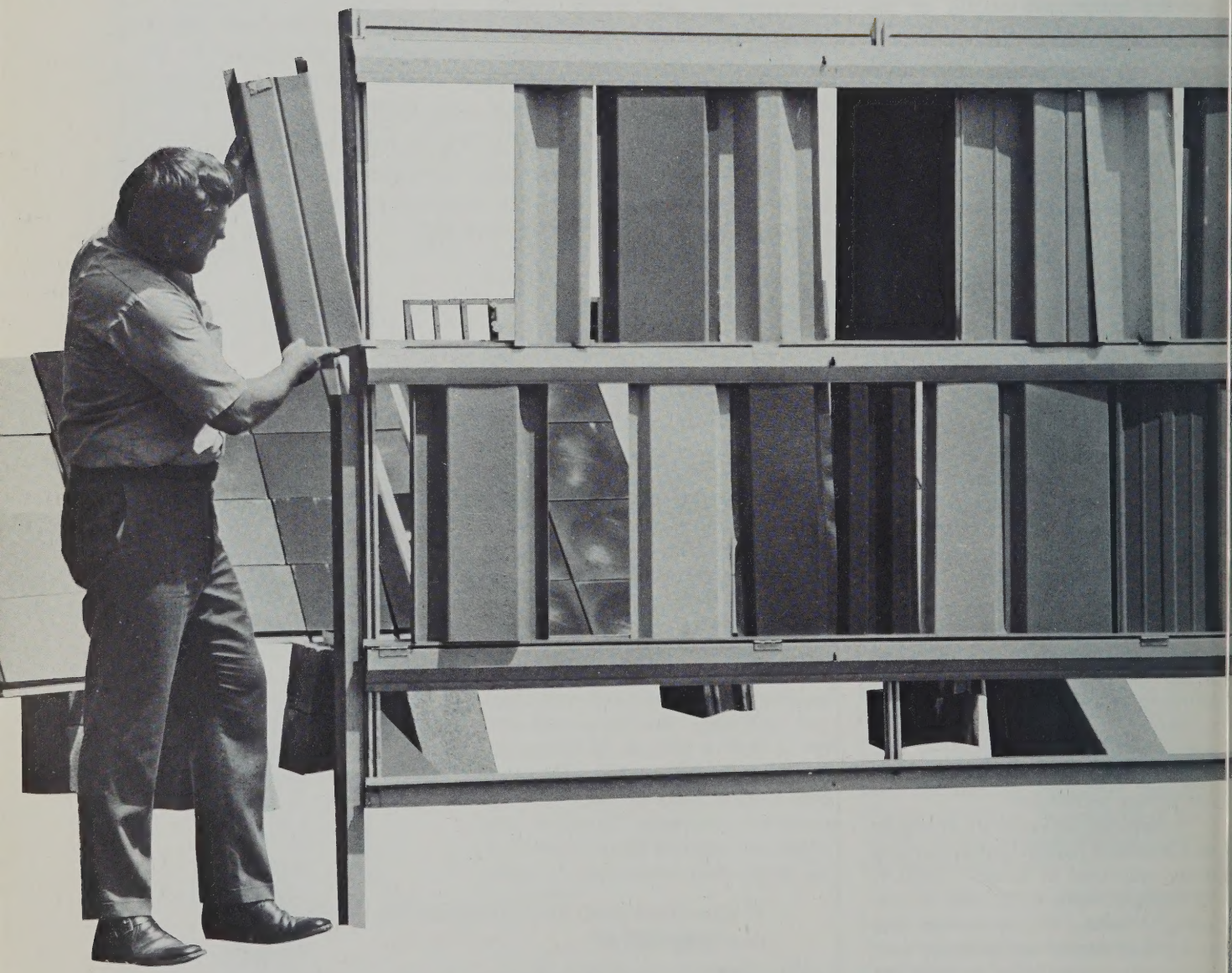
HOOTI RICPO USNST TPEMC AOOER

H.

If you need help in arriving at the solution, see page 214.

Determining the Effect of Weather on Building Materials

NBS technician places specimens of industrial siding material on one of ten anodized racks used to expose building materials to natural weathering conditions at NBS Gaithersburg Exposure Station.



A homeowner in the state of Washington and another in Nevada apply the same brand of exterior paint to their wood frame homes. Four months later the paint on one house has begun to peel and chip while the other has not. Since both homeowners used the same brand of paint on relatively similar surfaces, how can this difference in paint performance and durability be accounted for?

The answer—the homes were exposed to different weather conditions.

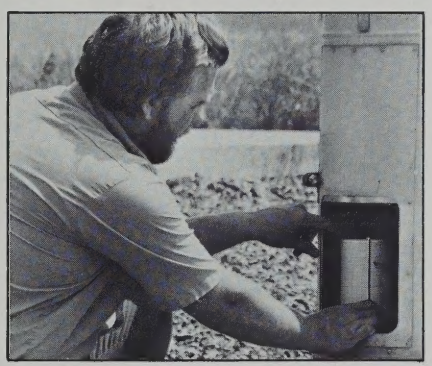
The situation posed in the riddle is hypothetical, but the need for the ability to predict the effect of "weathering" factors upon a building material's performance and durability is of increasing importance to the building industry. In order to make wise materials selection, builders, architects, and cautious homeowners need to know what kind of in-service behavior they can expect from exterior building materials such as paints and coatings, cladding (exterior coverings like siding), roofing, joint sealants, and stone. The need is particularly great when newer materials, for which little experience is available, are used as substitutes for traditional materials because of shortages or the demands of new building design concepts.

The National Bureau of Standards' Center for Building Technology (CBT) is involved in studies to determine the effects of weather factors such as solar radiation, temperature, moisture, pollutants, hail, and wind upon both traditional and innovative building materials. This information is helping in the development of ways to predict how a material will perform in use and how durable it will prove to be with time. Other factors such as imposed stresses, growth of microorganisms, chemical and physical compatibility between adjoining materials, and the manner in which the material is actually used are also important performance considerations which may have to be taken into account.

Dr. Gerald Sleater is a research chemist in the National Bureau of Standard's Center for Building Technology. Larry Masters is a research chemist and project leader for the Center's studies of the weathering of building materials.

NBS Studies

The NBS research on materials durability, conducted by CBT's Materials and Composites Section, involves two different types of tests: "Natural weathering" testing includes the natural exposure of materials both under in-service conditions, such as actual use in buildings, and at the NBS Exposure Stations; "accelerated weathering" testing simulates, on an intensified scale in the laboratory, natural weathering factors. Each test has its advantages and disadvantages.



Gaithersburg Exposure Station is equipped for continuous monitoring of ultraviolet and total solar radiation, rainfall, relative humidity, and temperature. Here, technician checks recordings made by rainfall monitor.

As the name suggests, natural weathering tests expose materials to natural weathering factors, usually at specially selected sites or exposure stations. The materials are inspected visually and their properties measured to assess changes due to weathering. In order to determine the rate of change, measurements taken prior to exposure and at various times of exposure are compared. Natural weathering tests are advantageous because the test results can often be interpreted directly in terms of in-service performance in the test climate. It is "real life" testing. The results, however, are often long in coming since long exposures may be required to obtain the necessary performance data.

NBS researchers therefore use a combination of natural and accelerated weathering tests, each test complementing the other. In fact, neither type of test alone is adequate for a complete materials test program. For example, while results are obtained sooner with accelerated weathering tests, it is impossible to duplicate exactly the complex effects of natural weathering on materials.

One NBS Exposure Station, located on NBS grounds in Gaithersburg, Md., is equipped for the continuous monitoring of ultraviolet and total solar radiation, temperature, relative humidity, and rainfall. To cover a wider range of climates and environments, NBS also maintains six other Exposure Stations from Alaska to Puerto Rico. The range of specimens presently on exposure includes paints and specialized coatings, roofing systems, sealants, residential and industrial cladding, stone preservatives, struc-

turn page

tural sandwich panels, waterproofing agents, plastic glazing compounds, plastic films and coatings, metals, and procelain-enamelled metals.

Accelerated weathering testing, though it may not fully simulate the effects of weather on materials, is selective, rapid, and reproducible. If properly selected, the changes in the materials' properties and the rate of change of performance can be roughly related to those brought about by natural exposure so that long-term performance can be predicted from the results. The present NBS accelerated testing capabilities include such weathering factors as temperature, temperature cycling, humidity, condensing moisture, salt spray and gaseous pollutant atmospheres, visible and ultraviolet radiation, and wet/dry cycling. The development of commercial weathering devices was largely based on the work of Percy Walker and Eugene Hickson at NBS. (Walker, P. H., and Hickson, E. F., Accelerated Tests of Organic Protective Coatings, *NBS J. Research, 1* (1928).

Testing may be designed to investigate the effects of a single factor or a group of factors. For example, in solar radiation testing, specimen temperature and test chamber humidity can also be controlled. Materials can be exposed to a sequence of separate tests, or to the combined effects of a selected group of factors. Through instrumental control of the test conditions, accelerated weathering testing can achieve reproducibility from test to test. The reproducibility, together with the savings in time and the commercial availability of test instrumentation, makes accelerated weathering an essential tool in building materials research and a valuable aid to building materials selection.

Applications

Using both the accelerated and natural weathering test methods, CBT conducts a variety of building materials studies for sponsors such as the Department of Housing and Urban Development, the Tri-Service Materials Committee of the Department of Defense, the National Park Service, and the Federal Highway Administration. The purpose is usually to develop performance criteria for materials selection. The data collected for each project is then made available to the building industry and general public through publication of the research results.

The use of weathering tests to aid the selection of materials offers significant benefits. One example of how these tests may be used involves an NBS study of industrial cladding carried out for the Tri-Services Committee of the Department of Defense. Specimens of one cladding were exposed at several Exposure Test Stations, but only those exposed at the marine environments of Cape May, New Jersey, and Roosevelt Roads Puerto Rico, Exposure Stations showed an unusual whitening of the coating. This whitening was not merely surface chalking but failure of the entire coating material. A subsequent investigation by the manufacturer indicated that this condition was due to a higher than normal temperature which had occurred dur-

Interior of the Single Carbon Arc where building material samples are exposed to ultraviolet radiation as part of NBS accelerated weathering testing.

ing cladding fabrication. Production controls were instituted and a potentially serious durability problem was avoided. More important, the results of the study have been incorporated in new guide specifications issued by the General Services Administration.

Natural weathering studies of building materials are also of international interest. A complementary program utilizing their Exposure Test Stations has been established between CBT and the Division of Building Research of the Canadian National Research Council. The program is intended to lead to international standards for monitoring of exposure conditions.

Future

Because of the problems with existing weathering tests, substantial research efforts are needed to improve the current technology. NBS is currently involved in a program which seeks to develop a methodology for durability prediction. This involves participation in committees of the American Society for Testing and Materials so that it may be introduced into the voluntary consensus standards process. In addition, new accelerated weathering tests may need to be devised to more nearly approach the natural weathering process.

As new exterior materials are developed, more and more testing will be required to predict their durability and performance. Foreseeing this increased demand, NBS plans to improve and extend the capabilities of its weathering facilities. Plans include improvement of the ultraviolet monitoring capabilities using standard light sensitive materials. Such materials should provide a convenient means of monitoring ultraviolet radiation in both natural and accelerated weathering tests. And part of the program to develop new weathering tests for building materials includes extending the weather monitoring capability of the Gaithersburg Exposure Station to other stations. The data obtained will be used to further quantify weathering factors so that improved accelerated tests can be developed.

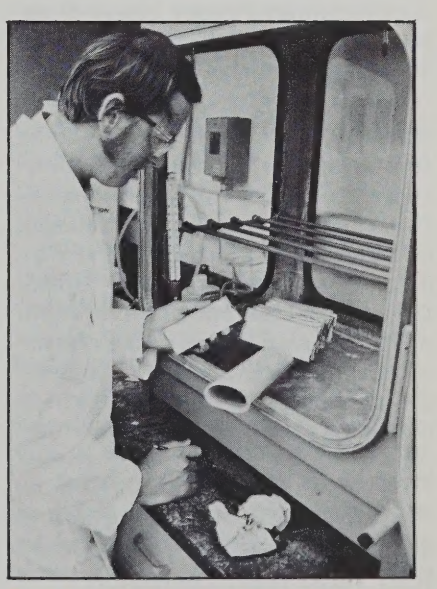
These new tests, together with present methods and use of NBS Exposure Stations, will lead to a better understanding of materials' performance and durability. This information will help meet the needs of the building industry and benefit both builder and consumer. □

NBS EXPOSURE STATIONS

NBS runs seven Exposure Stations throughout the U.S. and Puerto Rico, conducting natural weathering tests of building materials under a wide variety of climates and environments:

Location	*Type of Climate*
Gaithersburg, Maryland	Temperate, inland, warm summer, rural climate
Roosevelt Roads, Puerto Rico	Subtropical with salt atmosphere climate
Nellis Air Force Base, Nevada	Desert climate
Fort Holabird, Maryland	Temperate, inland, warm summer, industrial climate
Fort Lewis, Washington	Temperate, inland, cool summer climate
Fort Greely, Alaska	Subarctic climate
Cape May, New Jersey*	Temperate, warm summer, salt atmosphere climate

* racks at 24 and 240 meters from shoreline



Paint samples are exposed to sulfur dioxide in corrosive gas chamber, part of NBS' accelerated weathering testing facilities.

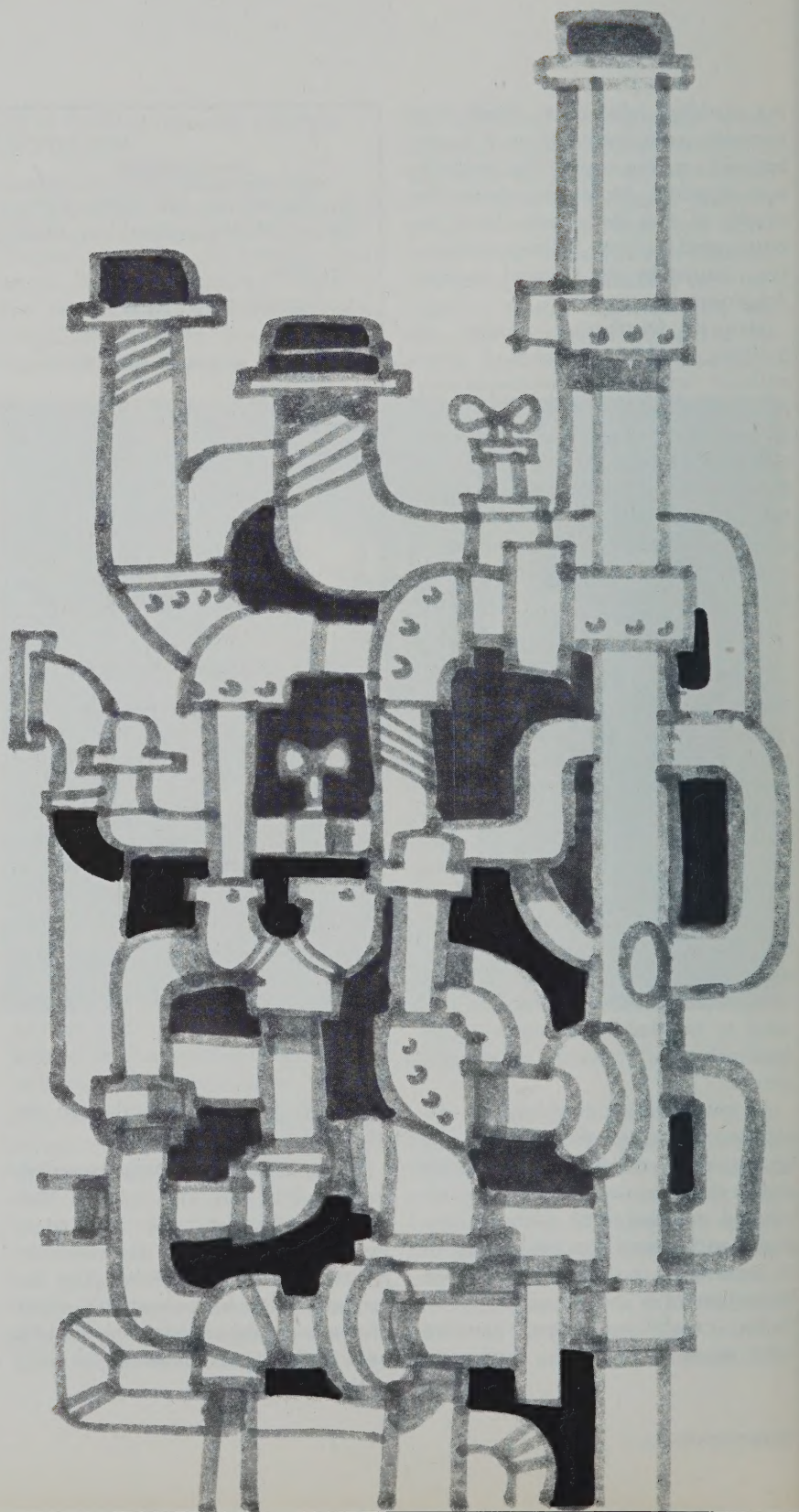
Plastic Pipes, Pros and Cons

AS construction costs of homes and other buildings continued to mount through the 1960's and into the 1970's, manufacturers, designers, and contractors sought ways to use new methods and materials that would provide acceptable performance at lower cost. One class of materials that was considered was thermoplastic pipe and fittings for plumbing. (A thermoplastic material is heat sensitive and capable of being repeatedly softened by increase in temperature and hardened by decrease in temperature.)

The thermoplastic pipe manufacturing industry began in this country in 1948. Improvements in impact strength, thermal properties, material consistency, and experience in installation have led to an increasing acceptance of plastic pipe and fittings by designers, contractors, and building code officials. The value of the products of the thermoplastic pipe manufacturing industry grew from $500,000 in 1948 to $50 million in 1957 to $548 million in 1972.

Because of this widening use of plastic piping in residential and other construction and the uncertainty about some of its performance characteristics, the National Bureau of Standards was asked by the Department of Housing and Urban Development to undertake a comprehensive examination of the criteria for thermoplastic piping for residential plumbing systems. The project is headquartered in the Center for

Widely used plastic piping materials are light weight and easy to work with, and they have high corrosion resistance.



Building Technology and draws upon the resources of the Center for Fire Research.

A recent NBS publication, "Review of Standards and Other Information on Thermoplastic Piping in Residential Plumbing," discusses the subject and the conclusions below are taken primarily from that report. It is one in a series of six planned reports on plastic piping in the NBS Interim Reports and Building Science Series publications. The final report on the study is planned for publication in early 1976, in the Building Science Series.

Thermoplastic piping and tubing are being used in building construction for water service and distribution piping; for drain, waste, and vent piping; for electrical conduit; and for gas service. Four thermoplastics have been the most widely used for residential plumbing, especially for one- and two-story single-family houses. They are: acrylonitrile-butadiene-styrene (ABS) and poly-vinyl chloride) (PVC) for drain, waste, and vent systems; chlorinated poly- (vinyl chloride) (PVC) for hot- and cold-water distribution systems; and polyethylene (PE) for underground water service piping.

Among the advantages of the plastic piping materials named above are that they are light weight and easy to work with, they have high corrosion resistance to water and many household chemicals, and they have little electrical conductivity, thus reducing problems of electrolytic corrosion.

The piping also has some potential disadvantages. Among these is the tendency of thermoplastic materials to soften and, for some materials, to deform when exposed continuously to very hot water for considerable periods of time. Also, their strength decreases as the temperature rises. These characteristics should be taken into account in the design of systems, especially in relation to the anticipated service environment.

Since these thermoplastics are more subject to destruction in building fires than are the traditional metals used in plumbing, they can contribute to the spread of fire, smoke, and toxic gases if not installed in accordance with specific guidelines.

Perhaps the major concern with plastic pipe for plumbing is the potential for spread of fire, smoke, and toxic gases in a burning building.

Mechanical cleaning of thermoplastic pipe with power-driven augers and rods may cause damage to the pipe unless care is taken in the choice of tools and in the manner of their use.

The light weight of thermoplastic piping also means it can contribute to the transmission of unwanted sound under some conditions. Consequently, appropriate noise-control techniques should be applied during installation of this piping.

Because of the lack of widespread, long-term experience with thermoplastic piping materials for residential plumbing, some degree of uncertainty still exists regarding the long-term durability and the susceptibility to bacteriological and biological attack. However, the increasing acceptance of these materials suggests that this concern is lessening with experience.

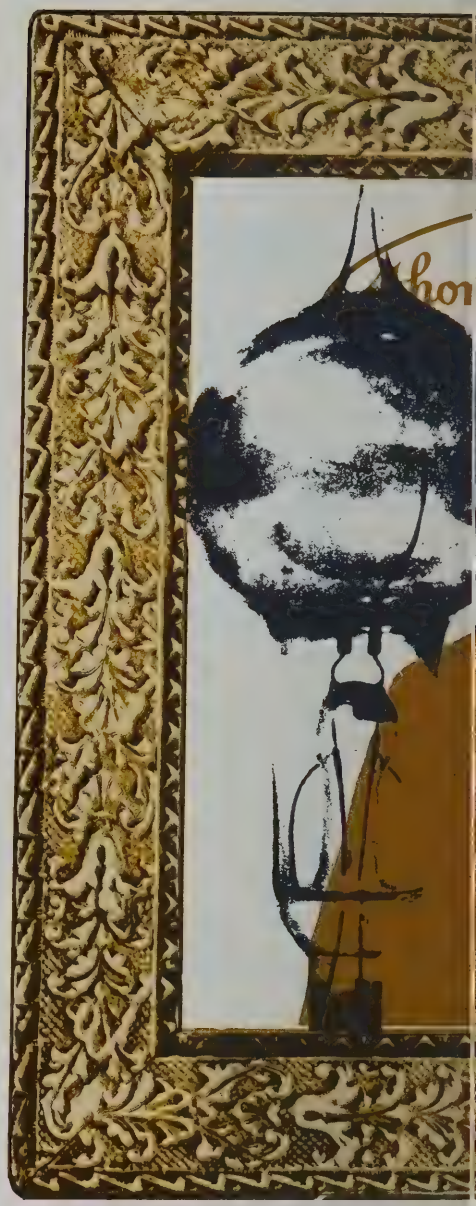
"Many of the potential disadvantages in using (plastic) piping systems in plumbing can be resolved with sensible design, assembly, and usage. Expenses to overcome the disadvantages are not great if the housing design incorporates the requirements prior to construction. However, if ignored, the potential disadvantages can sometimes become real disadvantages," report the NBS researchers.

The householder should be aware that one potential problem with thermoplastic piping is that some materials can be damaged to a degree by some household cleaning agents and solvents if the chemicals are not diluted and the period of exposure is long. Among household chemicals that could be deleterious to some plastic pipe under some conditions are chlorinated hydrocarbons, ethyl alcohol, tincture of iodine, gasoline, isopropyl alcohol (rubbing alcohol), linseed oil, naphtha, sodium hydroxide (lye), and turpentine.

"In the use of such chemicals, care should be taken to avoid disposal in a plastic drainage system, or else they should be adequately diluted and flushed through the system with copious amounts of water," advise the NBS researchers.

But perhaps the major concern with plastic pipe for plumbing is the potential it offers for spread of fire, smoke, and toxic gases in a burning building. When plastic pipe burns it provides heat for increasing the intensity of the fire, and it may provide a path for flame spread along its surface. During a fire, the burning or pyrolysis of the pipe within or adjacent to pipe penetrations through walls or floor-ceilings can provide passageways for smoke and hazard-

continued on page 213



As America faces its newest and possibly most difficult technological challenge, energy self-sufficiency, the nation is turning to its inventors for assistance. A brief look at the role invention has played in this country's past puts the new challenge—and its prospects for success—in perspective.

Energy Needs:
Newest Challenge to Yankee Ingenuity

Think of Yankee ingenuity and what comes to mind? American inventors and inventions. Edison, Bell, Ford, and Land are just a few of the inventors who have contributed to making the United States a leader in the industrialized world.

Inventors are not only the lifeblood of American technology. In times of national crisis they literally come to the rescue. During World War II, for example, Secretary of Commerce Harry L. Hopkins organized the National Inventors Council to help evaluate inventions pertaining to national defense submitted by the public. The distinguished panel consisted of outstanding inventors, industrial executives, educators, and patent lawyers. Numbered among them were Charles F. Kettering of General Motors Research Corporation, who served as the council's chairman, and Orville Wright, the pioneer in powered flight.

In less than 6 years time, more than 200,000 ideas were submitted by concerned citizens to the Council for evaluation and referral to the armed services. Of these, 8,600 were regarded as useful and 106 of them actually went into production. Others would also have been adopted except that World War II came to an end.

Among the valuable discoveries during this time were a land mine detector which saved thousands of lives, a trigger for the bazooka, a mercury dry cell battery for walkie-talkies, a mirror with which downed pilots could signal passing aircraft, and milkweed as a substitute for kapok in life preservers.

Post War Inventions

After the War, the National Inventors Council found a new home at

Thomas Edison may epitomize Yankee ingenuity, but many Americans, including NBS inventors H. L. Whittemore (left) and Jacob Rabinow (right) have made contributions of lasting value. In 1920's Whittemore co-invented steel proving ring, now commonly used in calibration of testing machines. Rabinow (right) and engineer Louis Shuman in 1948 demonstrated the holding ability of new type of electromagnetic particle clutch, which became basis for multimillion dollar industry.

the National Bureau of Standards, which had worked very closely with the Council during the war. NBS was a logical choice since it had many famous inventors and inventions to its credit. In 1960 the Office of Invention was established and acted as the operating arm of the National Inventors Council. In total, from 1940 to 1964 the National Inventors Council, aided by the NBS Office of Invention and Innovation, evaluated more than 600,000 inventions, nearly 13,000 of which were referred to other agencies for development.

In 1964 the Office of Invention and Innovation stopped evaluating inventions, but it still provided a series of services to inventors. It worked to establish programs and policies conducive to invention and innovation, planned and sponsored state and community meetings and expositions for inventors and entrepreneurs, worked with colleges and universities to improve methods of education for innovation, conducted studies and analyses of the psychology of invention and the inventive processes, and cooperated in innovative programs keyed to economic development in other parts of the world.

New Priorities

National needs and priorities were constantly changing, however. Recently, the National Inventors Council and Office of Invention and Innovation were disbanded. In their place is a new Office with which NBS, inventors, and inventions will continue to respond to a new, and, in many ways, more critical national need—energy.

This Office, the NBS Office of Energy-Related Inventions, was established to assist the Energy Research and Development Administration (ERDA) evaluate all promising, non-

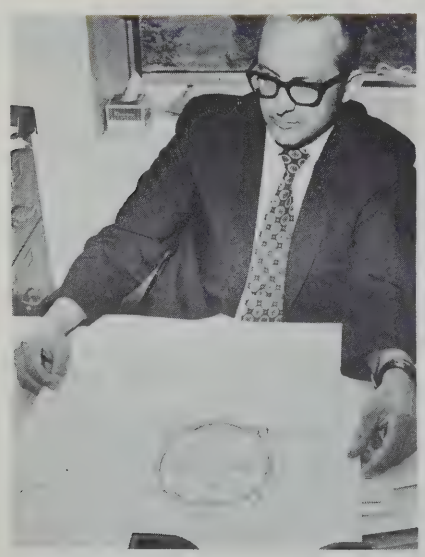
turn page

nuclear energy-related inventions, particularly those submitted by individual inventors and small companies for the purpose of obtaining direct grants for their development from ERDA. The responsibility for evaluating new ways and techniques for conserving or increasing the supply of energy was assigned to NBS by Section 14 of the Federal Nonnuclear Energy Research and Development Act of 1974. This act established a comprehensive national program for research and development of all potentially beneficial energy sources and utilization technologies.

"The main purpose of the NBS office," according to its chief, George Lewett, "is to insure that no significant energy-related invention is overlooked, particularly those from individual inventors and small firms."

Inventions submitted to NBS, with the understanding that NBS will safeguard the confidentiality of the inventions, will be evaluated in two phases. These separate evaluations may be conducted consecutively or concurrently, Lewett says. One phase will involve an evaluation of technical feasibility—that is, will the invention work the way the inventor says it will. The technical expertise available at NBS will be used to the maximum extent possible during this phase.

The Office of Energy Related Inventions, headed by George Lewett, expects to evaluate hundreds of inventions submitted by individuals and small firms.



Focal Point

The focal point in NBS for evaluations will be Jacob Rabinow, a well-known inventor and entrepreneur who has more than 200 patents to his credit. In addition to serving as chief research engineer of the NBS Institute for Applied Technology, Rabinow served as the executive secretary of the National Inventors Council for the Office of Invention and Innovation for many years. Rabinow will oversee the evaluations to make certain that they are thorough and objective. No invention will be rejected without at least two technical opinions, he says.

A second part of the evaluation will involve an analysis of practicability and/or commercial feasibility—that is, does the invention have utility and would it be used of commercially available. For the most part, this phase will be conducted by qualified firms or individuals in the private sector under contract to NBS.

Once completed, the results of the evaluation of an invention may be put in the form of a recommendation to ERDA, Lewett explains. This will be, in effect, a statement that the invention warrants the support of the government. "The support may take the form of financial assistance for testing, prototype development, or marketing in the form of a grant, loan, contract, or award," Lewett says, "depending on the state of the invention at the time we evaluate it." Lewett emphasizes that the nature and the extent of government support will be determined by ERDA, not NBS.

If NBS decides not to make any recommendation to ERDA, the inventor will be notified. "A decision not to recommend an invention to ERDA does not necessarily mean that the invention won't work or that it is without any value," Lewett explains. "It could mean that the invention lacked sufficient potential to warrant support by the Federal Government."

Rabinow sees the new Office of Energy-Related Inventions as an "opening wedge in creating an interesting climate for all inventors, not just those with energy-related inventions. The technology and health of the United States is highly dependent on the ingenuity and creative genius of inventors," Rabinow explains. "There should be a place somewhere in government to help and aid inventors."

People interested in submitting an invention to NBS for evaluation should write to the Office of Energy-Related Inventions, National Bureau of Standards, Washington, D.C. 20234. "NBS considers its new responsibility a most important one," Lewett says. "We feel we will provide ERDA and the nation with a vehicle by which important and promising inventions can best be identified for the most urgent task of helping us reduce our need and waste of energy." □

HIGHLIGHTS

Pacemaker Workshop at NBS

NBS, with the Food and Drug Administration of the Department of Health, Education and Welfare (HEW), sponsored a workshop in July to discuss "Reliability Technology for Cardiac Pacemakers." The workshop directed primary attention to: (1) procurement and assurance of reliable, long-lived semi-conductor electronic parts; (2) hermeticity testing of device packages and pacemaker systems; (3) activities of several standardization organizations; and (4) use of reliability data banks and other information and service sources. The Workshop was attended by 121 registrants from industry, government, universities, press, Congress and other organizations. All 10 of the known domestic manufacturers of pacemakers were represented.

The technical sessions of the Workshop highlighted the problems associated with obtaining high reliability electronic components—problems shared with the most demanding users in the military and space communities. It was, however, noted that no government agency has the authority or responsibility for the development of methods to permit assured procurement of high quality electronic components for critical applications in the civilian sector. In the closing session, it was recommended that an annual meeting be established, and several participants volunteered to assist NBS in such development.

Crystal Data on Magnetic Tape

A magnetic tape containing selected data from the NSRDS publication, *Crystal Data Determination Tables,* 3rd Edition (J. D. H. Donway and H. M. Ondik, 1972, 1973) has been made available through the NBS Magnetic Tape Series. The tape contains the following data for approximately 24,000 crystalline compounds: unit cell parameters, Z, space group, measured density, x-ray density, and determinative radio. It is available for lease from the National Technical Information Service, Springfield, Va. 22151, as NBS Magnetic Tape No. 9 at a price of $1,000.

New SRM Catalog

The 1975-76 Standard Reference Materials Catalog and its associated price list has been released. It contains a detailed listing of more than 900 Standard Reference Materials (SRM's). Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.50. Order by SD Catalog No. C13.10:260-1975-76.

Biomaterials Publication

NBS Special Publication 415 entitled "Biomaterials" has recently been released. It is based on papers presented at a 1974 symposium on biomaterials. The aim of this publication is to review some of the important advances that have been made in materials used for synthetic implants. Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.75 Order by SD Catalog No. C13.10:415.

Lead Paint Survey Completed

According to a survey by NBS under the sponsorship of the Department of Housing and Urban Development (HUD), youngsters in Pittsburgh have a low incidence of lead paint poisoning despite a large number of old houses with lead paint. The University of Pittsburgh and the Alleghany County Health Department will submit a proposal for research to be funded by HUD through NBS to investigate this phenomenon.

Solar Heating and Cooling Costs

A recent NBS report outlines for researchers and analysts the use of life-cycle cost analysis for evaluating and comparing the economic efficiencies of solar and conventional heating and cooling systems. Copies of the report, "Solar Heating and Cooling of Buildings: Methods of Economic Evaluation," are available from the National Technical Information Service, Springfield, Va. 22151, as NBSIR 75-712 for $3.75.

New Fire Test Enclosure

NBS has designed a laboratory scale enclosure which allows actual observation and measurement of the interaction of building materials and furnishings in a room fire. The enclosure's use as a tool for predicting full-scale fire behavior is discussed in NBSIR 75-710, "A Small Scale Enclosure for Characterizing the Fire Buildup of a Room," available from the National Technical Information Service, Springfield, Va. 22151, for $3.25.

New Voluntary Product Standard

Voluntary Product Standard PS 63-75, 'Latex Foam Mattresses for Hospitals," is now available. This standard was developed by NBS to establish dimensional and quality requirements for latex foam mattresses intended for use in hospitals. It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 50 cents. Order by SD Catalog No. C13.20/2:63-75. □

Cryogenic Fluid Safety Data Compiled

A collection of data for the safe handling of cryogenic (very low temperature) fluids, plus lists of publications and other sources of information on the subject, have been prepared by the Cryogenic Data Center of the National Bureau of Standards in collaboration with the National Aeronautics and Space Administration (NASA).

Safety-related information sources have been compiled by NBS on helium, nitrogen, oxygen, air, zone, fluorine, methane, and liquefied natural gas (LNG), with special emphasis on hydrogen, oxygen, and methane.

A thorough understanding of safety procedures for dealing with cryogenic fluids is essential because of the huge quantities of these materials used in industry and the large and increasing number of persons occupationally concerned with them. Fortunately, safe handling techniques for the different fluids have been established, all of which are covered in the NBS-NASA information bank.

At the extremely cold temperatures of cryogenic systems, for example, some materials become brittle and may fracture. What one mainly needs here is information about which materials these are and how they behave at low temperatures.

Gaseous and liquid hydrogen and methane are flammable and explosive. Yet, properly handled and controlled, they can be used as safely as any other fuel.

Oxygen at cryogenic temperatures readily oxidizes many ordinarily nonflammable, as well as flammable, materials. Liquid oxygen, combining with oil, grease, asphalt, and many plastics and organic materials, forms shock-sensitive detonable mixtures. The problem is largely one of keeping areas and systems meticulously clean.

Individuals exposed to liquid oxygen must also have a thorough knowledge about certain related hazards. Personal clothing that touches liquid oxygen, for example, should be removed immediately. And prolonged exposure to high levels of oxygen near atmospheric pressure can damage the bronchial tubes and lungs and cause bronchitis, pneumonia, and lung collapse. Oxygen handling areas must therefore be confined and well ventilated, fireproofed, and without ignition sources.

Data and sources of information needed for the safe handling and use of cryogenic fluids are contained in the NBS-NASA compilation. They are available to the public through the Aerospace Safety Research and Data Institute of the National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio 44135. □

Titanium metal burning in pure oxygen dazzles the eye during experiments related to safe handling of oxygen.

Optical Spectra Tables Revised

THE National Bureau of Standards has just issued a second, considerably revised edition of a set of data tables much used by spectrochemists, astrophysicists, atomic physicists, and others.

NBS Mongraph 145 Tables of Spectral-Line Intensities, by William F. Meggers, Charles H. Corliss, and Bourdon F. Scribner, supplies data on spectral lines of 70 chemical elements, mostly metals, the spectrochemist can normally expect to encounter. The data are used in identifying and determining the relative amounts of the different atoms and ions present in a sample. Astrophysicists have found the same information serviceable in studying the chemical constitutents and processes in stellar atmospheres.

Like its predecessor (published in 1961 as NBS Mongraph 32), the new edition tabulates the intensity, character, wavelength, spectrum, and energy levels of 39,000 lines between 2000 Å and 9000 Å in the spectra of 70 elements. It is again divided into two parts, each in its own hard-cover volume. Part I lists the lines by element, taking the elements in alphabetical order. Part II consolidates all observed lines into a single table arranged in order of increasing wavelength and a supplementary table of selected strong lines.

The line intensities were determined at NBS by a uniform procedure designed to make the data reliably interpretable over a wide range of experimental conditions. Each element was mixed with pure copper powder in the atomic ratio of 1 to 1,000, the mixture was pressed into solid electrodes, and the electrodes burned in a 220-volt, 10-ampere d.c. arc which was imaged entirely on the collimator of a grating spectrograph. A rotating step sector reduced intensities to 1/5 in each of four steps. Intensities were estimated by comparison with those of selected lines in the copper spectrum. Intensities of the selected copper lines were measured, for wavelengths above 3300 Å, against a calibrated tungsten-strip filament and, for 2500 Å to 3300 Å, against a calibrated hydrogen lamp.

NBS is also responsible for a large number of the wavelengths and energy levels listed. Many other sources were used, however, including some that are unpublished. All sources are, of course, identified.

In the first (1961) edition, energy levels were assigned to only about 25,000 of the 39,000 lines. Since then about 8,500 additional lines, chiefly in the rare-earth spectra, have been assigned levels, and these are included in the new edition.

Then too, since the first edition, many wavelengths have been remeasured. It has thus been possible for the new edition to provide improved wavelengths (accurate to 0.01 Å) for about 9,000 lines.

Of importance also are the changes in the intensity scale for the new edition, especially the incorporation of the new calibration of the region below 2500 Å which Corliss published in 1967 (Supplement to NBS Monograph 32). Further, as a matter of convenience—to eliminate fractional numbers—the whole scale of relative intensity has been multiplied by ten, so that the numbers now range from 1 to 90,000. *turn page*

Astrophysicists studying stellar atmospheres utilize optical spectra data furnished by NBS, as do researchers in a number of other fields.

OPTICAL *continued*

The senior author, Meggers, died in 1966, and the second edition was prepared by Corliss and other members of the NBS staff.

Copies of NBS Monograph 145 can be ordered prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Part I, Tables of Spectral-Line Intensities Arranged According to Wavelength, 228 pages, is $6.80 per copy (order as SD Catalog No. C13.44:145/I). Part II, Tables of Spectral-Line Intensities Arranged According to Wavelength, 228 pages, is $6.80 per copy (order as SD Catalog No. C13.44:145/II). □

Energy Labeling Explained for Consumers

A slide-tape presentation on the Commerce Department's Voluntary Energy Conservation Labeling Program for Household Appliances and Equipment is now available for sale to consumer groups and the general public.

"Conserving Energy Through Appliance Labeling" explains the purpose and goals of the labeling program, which was begun in 1973. Under the program, participating companies label their products with Energy Guide Labels to indicate their energy consumption and their relative efficiency in comparison to other competitive models. Where it is practical, the cost of operating the appliance appears on the label.

Featured in the 6½ minute presentation is a close look at room air conditioner Energy Guide Labels. The presentation explains how the information on the labels can help a consumer buy the most efficient model for his or her needs—and save energy and money in the process.

Room air conditioners are the first appliances to be labeled under the appliance labeling program. Energy Guide Labels are now appearing on nearly all room air conditioner units in the marketplace.

Future slide-tape programs will feature other appliances scheduled to be labeled, such as refrigerators, freezers, refrigerator-freezers, dishwashers, clothes washers and dryers, kitchen ranges and ovens, central air conditioners, comfort heating equipment, and television sets.

The slide-tape show was prepared by the National Bureau of Standards, which developed the Energy Guide Labels and provides other technical support for the Commerce Department program. The show is aimed at consumer groups, home economics teachers and classes, and audit education courses. It can also be used by retail appliance stores as a training aid for salespeople.

The slide show may be purchased from the National Audio Visual Center, General Services Administration, Washington, D.C. 20409—Attention Order Department. The show costs $10 and includes a set of 56 slides, a programmed audio-cassette, and a script.

Further information can be obtained from the National Bureau of Standards, Appliance Labeling Section (441.01), Washington, D.C. 20234. □

NBS, GSA Experiment for Savings and Product Improvement

THE Federal Government's enormous purchasing power is being used in two experimental programs designed to improve product technology and save money.

The experiments are a cooperative venture between the National Bureau of Standards' Experimental Technology Incentives Program (ETIP) and the General Services Administration's

Federal Supply Service (FSS).

In the first experiment, a new clause was inserted into all FSS contracts for the purchase of supplies and equipment in amounts exceeding 100,000 dollars. It may be used in contracts less than 100,000 dollars at the discretion of the FSS.

Termed a value incentive clause (VIC), it encourages government suppliers to make changes to specifications which will result in cost savings to the government. The supplier then shares these savings with the government.

VIC stimulates contractors to seek ways to produce more cost-effective products, including the use of new technology, because they and their sub-contractors share directly in any net savings to the government. GSA expects that contractors will make manufacturing changes that decrease the cost of production and/or reduce the cost of ownership for the government.

The potential savings from the application of VIC are great because the GSA buys 2 billion dollars worth of supplies and equipment every year.

The second experiment is the extensive use of life cycle costing (LCC) in Federal Supply Service procurements. LCC takes into account other costs of owning an item, as well as the initial acquisition costs in the award of contracts. Therefore, a product with a high initial cost but low lifetime operating cost may have a lower total cost of ownership and would be selected over a competing product that was less expensive to buy but costlier to operate.

FSS's first use of LCC was in the procurement of 27,000 window air conditioners. These units, which on the average are 21 percent more efficient than the previous year's models, are expected to save the government approximately 400,000 dollars in utility costs (at current rates) over the 7-year life of the units.

The LCC concept will be used over the next few months in the procurement of 15,000 frostless refrigerators, 7,700 home water heaters, and 25,000 household ranges. The identification and selection of approximately 50 other items for similar procurement will occur during the next fiscal year.

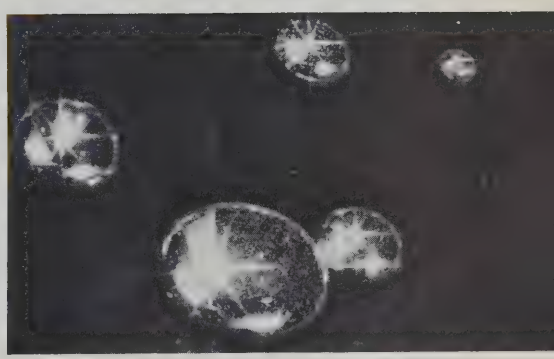
ETIP also assisted FSS in developing an LCC training program. The FSS Training Division will offer this 40-hour workshop to Federal, state, and local procurement officers throughout the country. □

Thermal Conductivity Discussed

Thermal Conductivity of the Elements: A Comprehensive Review has just been published as Supplement No. 1 to Volume 3 (1974) of the Journal of Physical and Chemical Reference Data.

The review is by C. Y. Ho., R. W. Powell, and P. E. Liely, staff members of the Thermophysical and Properties Research Center at Purdue University, and is published by the American Chemical Society (ACS) and the American Institute of Physics (AIP) for the National Bureau of Standards.

The available data on the thermal conductivity of the elements are compiled, discussed, and critically evaluated in this volume. The temperature range covered is that covered by the experimental data. Where no experimental measurements have been made, values have been estimated for temperatures in the vicinity of room temperature. Experimental data were found to be available for 82 elements and estimated values found for another four. Estimates were made on the remaining 19 elements for this review.



The thermal conductivity of mercury is of interest to a broad range of scientists and engineers, especially in view of the fact that it is used in nearly pure form as an engineering material

In addition to the recommended or estimated values, the raw data sets have been compiled, the characterization of the samples and the measurement techniques have been discussed, the considerations involved in evaluating the data have been given along with the theoretical guidelines and semi-empirical equations used to interpolate, correlate and estimate

turn page

REVIEW *continued*

values, and complete bibliographic citations are listed. The discussion covers 5,200 sets of data drawn from 1,658 references. The bibliographic cut-off date is January 1971.

This volume should be useful to many scientists and engineers. It provides engineering and design data for those elements such as tungsten, molybdenum, carbon (as graphite), aluminum, copper, germanium, silicon, (in the liquid state), and mercury, which are used in nearly pure form as engineering materials. It provides data for use in calibrating and checking experimental techniques for use as standards in comparative measurements.

Finally, it provides a reference base for further theoretical development of the understanding of thermal conductivity and for setting priorities for further experimental measurements. Although there is now no satisfactory method of estimating the thermal conductivity of multi-component solids such as alloys, any such method to be developed will require the thermal conductivities of the component elements as reference data.

An abridged version containing recommended reference values but no discussion has also been published (Journal of Physical and Chemical Reference Data *1, 279,* 1972).

Consisting of 796 pages and bearing Library of Congress Catalog Number 75-4440, the review is available without subscription to the Journal from the American Chemical Society Subscription Service Department, 1155—16th Street, N.W., Washington, D.C. 20036.

Prices are: Hard Cover, $60.00; soft cover, (nonmember), $55.00; soft cover, (member), $25.00. □

Computer Program Announced

DR. Ruth M. Davis, Director of the Institute for Computer Sciences and Technology of the National Bureau of Standards, and Mr. T. D. Puckorious, Commissioner of the Automated Data and Telecommunication Service of the General Services Administration (GSA), have announced joint approval of a cooperative program of work in computer interface standards.

Both NBS and GSA share a strong concern that Federal agencies be able to successfully procure and use the least expensive ADP equipment and services that satisfy their requirements. The development and use of computer interface standards which facilitate the competitive procurement of computer peripheral equipment has long been actively supported by both agencies and is an important part of the newly approved cooperative program.

This new cooperative program includes four tasks. First, the collective Federal Government experience with multi-vendor computer systems will be assimilated and made available to Federal agencies. Second, technical guidelines will be prepared to assist Federal agencies to successfully plan, select, and operate multi-vendor configurations. A government-wide interagency task group is being formed to address these two tasks.

The third task, already underway, is the identification of existing similarities and differences in the device level interface employed with high density disk drives. Expected follow-on efforts that are part of this task will focus on other commonly used peripheral devices, such as magnetic tape, memory, printers, card readers, punches, and display devices. It is anticipated that the results of these efforts will serve to further Federal and national standards activities in the interface area.

A fourth task involves the evaluation of the technological and economic impact of establishing international, national, and Federal computer interface standards. This evaluation will provide a basis for establishment of possible future Federal procurement policies that may be required with regard to the acquisition of ADP systems and peripheral components.

These tasks build on each agency's continuing active participation in the development of computer interface standards through voluntary industry effort under the American National Standards Institute (ANSI) and the International Standards Organization (ISO). NBS and GSA endorse the development of such voluntary computer interface standards that may serve as a basis for Federal ADP standards. □

ous gases between rooms under some conditions.

In another Building Science Series Report, "Fire Endurance of Gypsum Board Walls and Chases Containing Plastic and Metallic Drain, Waste and Vent Plumbing Systems," NBS researchers describe 10 full-scale fire endurance tests made on walls or chases, each test involving up to four plumbing systems of designs that might be used in one- and two-story structures. In tests where the plumbing simulated a particular kitchen drain system, PVC piping did not contribute to the spread of fire from one side of the construction to another.

More than half the tests were run using kitchen sink drain systems as installed in wood-stud and gypsum-board walls. NBS researchers found that the plumbing configuration and wall construction details, particularly the sealing of plumbing penetrations and the depth of the wall, significantly affected the fire endurance of the simulated barrier between dwelling units. The ability of the construction to prevent the spread of fire from one dwelling unit to another for 1-hour was a principal criterion in the tests.

The ABS and PVC piping assemblies used in these tests passed the 1-hour fire endurance requirement when pipe penetrations into walls were sealed, when the wall cavity depth was 13.75 centimeters (5½ inches) or more, and when the maximum diameters of the pipes were limited to 5 to 7.5 centimeters (2 to 3 inches). The fire endurance of the construction fell short of the 1-hour mark when the plumbing fittings pentrated the wallboard, when holes around laterial piping were not sealed and when the plastic piping was used in a 8.75 centimeter (3½ inch) deep wall cavity with either wood or steel studs.

In tests which involved walls made of 2" by 4" (5 by 10 centimeters) studs and gypsum board, the 1-hour fire resistance rating of the wall was reduced considerably when certain construction configurations were used. These configurations included back-to-back 3.75-centimeter (1½-inch) diameter lateral pipes feeding directly into 5-centimeter (2-inch) diameter vertical pipes.

The NBS investigators concluded that plastic drain-waste-vent piping systems—with lateral (horizontal pipe) penetration sizes of 5 centimeters diameter or less—should meet the 1-hour fire resistance test in wood - stud - and - gypsum - board walls provided the hole around the lateral piping where it penetrates the wall is sealed and the stud space is of sufficient depth so that piping hubs do not penetrate the walls.

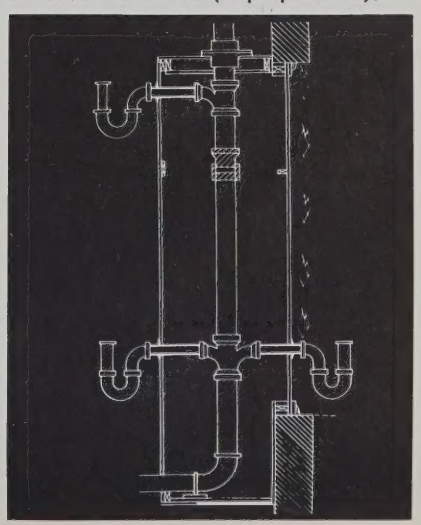
Among items that were essentially outside the scope of the work reported were the development of specific criteria for the spread of smoke and toxic gases associated with walls and chases containing plastic piping and the testing for fire endurance of a range of varying plumbing configurations unlike those that were used in the NBS tests.

Generally, NBS researchers are finding that plastic piping for residential plumbing can be an effective substitute for metallic piping in selected wall and chase constructions provided certain precautions are taken by the building designer, by the contractor who installs the plumbing, and by the occupant who makes daily use of the plumbing system.

Additional results and more detail will be found in the individual reports on the various portions of the investigation. These are shown in the inset. □

REPORT TITLES

1. Review of Performance Characteristics, Standards and Regulatory Restrictions Relating to the Use of Thermoplastic Piping in Residential Plumbing. NBSIR 74-531, March 1975; also issued as Review of Standards and Other Information of Thermoplastic Piping in Residential Plumbing. BSS 68 (May 1975).
2. Investigation of Procedures for Determination of Thermal Performance Characteristics of Plastic Piping Used in Housing. NBSIR 74-610 (November 1974).
3. Laboratory Tests of Selected Thermoplastic Piping Assemblies Subjected to Pressure Shock and Intermittent Hot-Water Flow. To be issued as an NBSIR (in preparation).
4. Fire Endurance of Gypsum Board Walls and Chases Containing Either Plastic or Metallic Drain, Waste and Vent Systems. BSS 72 (in press).
5. Thermal Properties of Selected Piping Used in Housing. To be issued as NBSIR 74-629. (in press).
6. Final Report: Investigation of Standards, Performance Characteristics and Criteria for Thermoplastic Piping Systems for Residential Plumbing. To be issued as a BSS (in preparation).



Solution to Cryptogram

The cryptogram on page 197 is a *transposition cipher,* where the meaning is hidden by a prearranged scramble of the letters. In this case a keyword, CRYPTOGRAPHY, was used.

The letters of the keyword are written out and duplicate letters omitted, leaving CRYPTOGAH. The message is written out in nine-letter rows under the keyword. Since there are 76 letters in the message, there will be eight full rows of message with five blanks left in the ninth row. The letters of the keyword are then arranged alphabetically, giving ACGH OPRTY, and the columns of letters underneath are shifted the same way:

C	R	Y	P	T	O	G	A	H
t	h	e	m	o	d	e	r	n
c	o	m	p	u	t	e	r	p
r	o	c	e	s	s	o	f	d
a	t	a	e	n	c	r	y	p
t	i	o	n	s	t	e	m	s
f	r	o	m	t	h	e	a	n
c	i	e	n	t	a	r	t	o
f	c	r	y	p	t	o	g	r
a	p	h	y					

A	C	G	H	O	P	R	T	Y
r	t	e	n	d	m	h	o	e
r	c	e	p	t	p	o	u	m
f	r	o	d	s	e	o	s	c
y	a	r	p	c	e	t	n	a
m	t	e	s	t	n	i	s	o
a	f	e	n	h	m	r	t	o
t	c	r	o	a	n	i	t	e
g	f	o	r	t	y	c	p	r
	a				y	p		h

The final step in encrypting the message is to print groups of five letters in the order that the letters now appear if the matrix is read from top to bottom of each vertical column, beginning with the left-hand column: RRFYM ATGTC, and so on.

To "break" the cipher, we reverse the process and read:

THE MODERN COMPUTER PROCESS
OF DATA ENCRYPTION STEMS
FROM THE ANCIENT
ART OF CRYPTOGRAPHY.

Technical Summary of Encryption Algorithm

The algorithm is designed to encipher and decipher blocks of data consisting of 64 bits under control of a 64 bit key. Deciphering must be accomplished by using the same key as for enciphering, but with the schedule of addressing the key bits reversed so that the deciphering process is the inverse of the enciphering process. The data to be enciphered or deciphered is subjected to the algorithm diagrammed in Figure 1 and outlined below.

Each input block, either of data or cipher, is transformed with the following steps:

1. An initial 64-bit permutation, or "shuffling," of the input data into two data vectors (L and R) of 32 bits each.

2. For N = 1,2,. . .,16, perform the following operations:

   a) Set L′ = R.

   b) Set R′ = the sum (modulo 2) of L and the result of combining R with a subset K_N of the encryption key using the combining function F (see Figure 2).

   c) Set L = L′ and R = R′.

3. A final 64-bit permutation of L′ and R′ into an output block which is ready for transmission or use.

The security of the algorithm is provided by the combining function F.

The calculation of $F(R,K_N)$ is diagrammed in Figure 2 and summarized below.

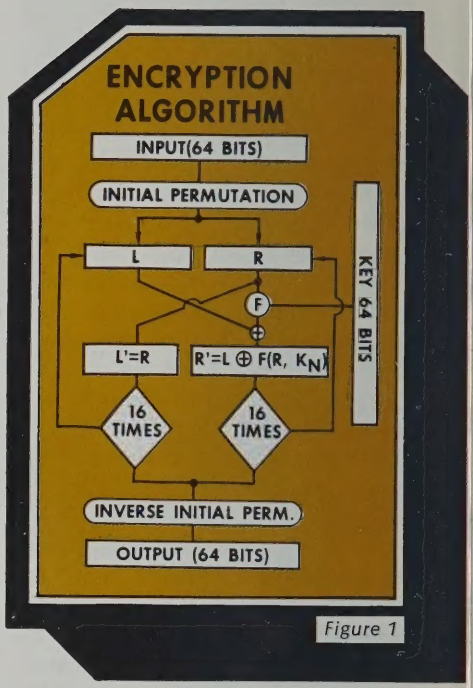


Figure 1

E is an expansion operation which duplicates selected bits of R and results in a 48-bit vector. KS is a key schedule function which selects a 48-bit subset K_N of KEY. S1 through S8 are substitution tables which are used to replace successive 6-bit bytes of the sum (modulo 2) of these 48-bit vectors with 4-bit values found in the corresponding tables. P is a 32-bit permutation which shuffles the bits resulting from the eight separate substitution operations and results in $F(R,K_N)$. The same F is used to decipher data except that the K_N are used in reverse order, i.e., N = 16,15,. . .,1. (The complete algorith is available from the Systems and Software Division, Code 103, Technology A265, National Bureau of Standards, Washington, D.C. 20234).□

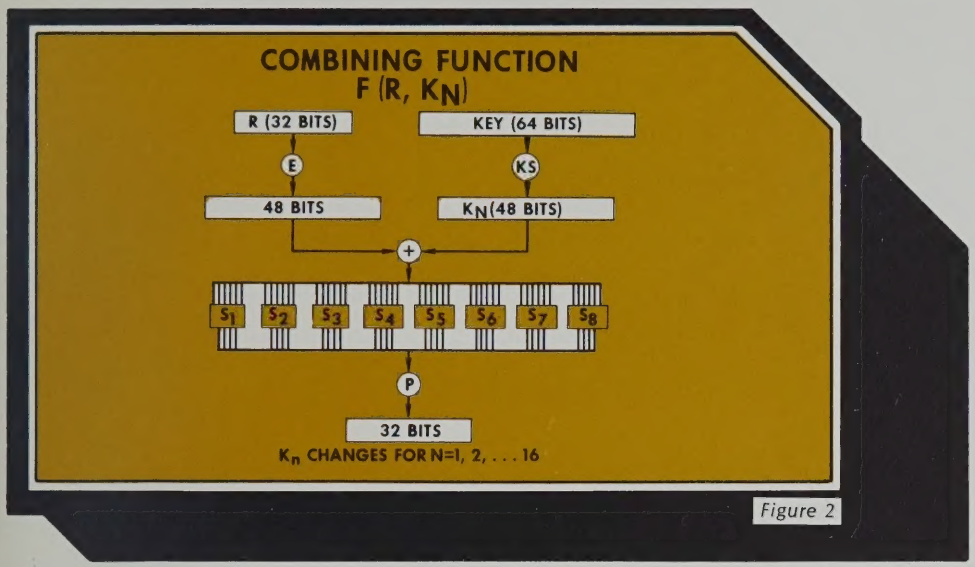


Figure 2

PUBLICATIONS

of the National Bureau of Standards

Building Technology

Meese, W. J., and Cilimberg, R. L., *Analysis of Current Technology on Electrical Connections in Residential Branch Circuit Wiring,* Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 63, 23 pages (Mar. 1975) SD Catalog No. C13.29:2/63, 70 cents.

Wyly, R. S., Parker, W. J., Rorrer, D. E., Shaver, J. R., Sherlin, G. C., and Tryon, M., *Review of Standards and Other Information on Thermoplastic Piping in Residential Plumbing,* Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 68, 65 pages (May 1975) SD Catalog No. C13.29:2/68, $1.25.

Computer Science and Technology

Stillman, R. B., and Leong-Hong, B., *Software Testing for Network Services,* Nat. Bur. Stand. (U.S.), Tech. Note 874, 40 pages (July 1975) SD Catalog No. C13.46:874, $1.00.

Energy Conservation and Production

Berry, S. A., *Emergency Workshop on Energy Conservation in Buldings,* Nat. Bur. Stand. (U.S.), Tech. Note 789-1, 31 pages (July 1975) SD Catalog No. C13.46:789-1, 80 cents.

Engineering, Product and Information Standards

Little, J. L., *Code Extension Techniques in 7 or 8 bits,* Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 35, 4 pages (1975) SD Catalog No. C13.52:35, 25 cents.

Little, J. L., *Graphic Representation of the Control Characters of ASCII (FIPS 1),* Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 36, 4 pages (1975) SD Catalog No C13.52:36, 25 cents.

Standard Reference Data

Meggers, W. F., Corliss, C. H., and Scribner, B. F., *Tables of Spectral-Line Intensities. Part I—Arranged by Elements,* Nat. Bur. Stand. (U.S.), Monogr. 145, 403 pages (May 1975) SD Catalog No. C13.44: 145/I, $8.55.

Meggers, W. F., Corliss, C. H., and Scribner, B. F., *Tables of Spectral-Line Intensities. Part II—Arranged by Wavelengths,* Nat. Bur. Stand. (U.S.), Monogr. 145, 228 pages (May 1975) SD Catalog No. C13.44:145/II, $6.80.

Other Subjects of General Interest

Collins, B. L., Windows and People: *A Literature Survey. Psychological Reaction to Environments With and Without Windows,* Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 70, 93 pages (June 1975) SD Catalog No. C13.29/2:70, $1.55.

Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.